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HEAT AND MASS TRANSFER DURING THE  
ATOMIZATION OF LIQUID

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**ABSTRACT:**

Several papers on the thermal dehydration of liquids - liquids in dispersed state, presented in the All-Union Conference on Heat and Mass Transfer, are reviewed. Problems of the analysis and design of the processes of heat and mass exchange during spray drying are defined.

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TEPLO - I MASSOPERENOS

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MATERIALS OF DISCUSSION IN THE  
ALL-UNION CONFERENCE ON HEAT AND  
MASS TRANSFER

Edited by A. V. Lykov, Academician AN BSSR  
and B. M. Smol'skiy, Corresponding member AN BSSR

MINSK, 1969

## HEAT AND MASS TRANSFER DURING THE ATOMIZATION OF LIQUID

B. I. LEONCHIK, A. A. DOLINSKIY

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## HEAT AND MASS TRANSFER DURING THE ATOMIZATION OF LIQUID

(Survey Paper)

Problems of the analysis and design of the processes of heat and mass exchange during the movement of the drops of different liquids arise in connection with the construction and improvement of several devices: scrubbers, dryers, conditioners, motors, etc.

Unfortunately, the papers presented in this conference do not completely characterize the present state of affairs of the problem. The problem as a whole has a complex character:

- 1) kinetics of heat and mass exchange of single drops with the surrounding medium;
- 2) peculiarities of heat and mass exchange of the aggregate of polydispersed drops with the surrounding medium;
- 3) aerodynamics and heat-mass transfer in chambers of industrial devices;
- 4) approximate simulation of processes, design and construction of devices;
- 5) optimization of the operation of industrial devices, including the problems of measurements, automatization and control.

Problems of technology have independent, often decisive importance, especially during the implementation of the processes of spray drying.

Considering the subjects of the present section, we would only mention some papers on thermal dehydration of liquids - liquids in dispersed state.

Papers of M. V. Lykov and his colleagues differ in technological newness and successes in the field of industrial realization. The combined apparatus RKSG, in which the principle of jet-spray drying is combined with final drying and granulation of the product in the boiling layer, can be mentioned as an example. On the example of this device methodical basis for the atomization a wide class of dryers has been developed.

A group of scientists under the leadership of A. N. Planovskiy in the Moscow Institute of Chemical Machine Engineering (A. P. Fokin, V. I. Mushtaev and others)

are engaged with a comprehensive study of spray dryers, including investigations under industrial conditions, as well as with the improvement of the method of their engineering design.

Their data on the mixing in chambers of dryers and on the influence of polydispersion and hygroscopic properties of the product etc. on the driving force are of great value.

On the basis of this data it is possible to more accurately determine the average driving force in dryers and, consequently, the reliable determination of their sizes.

Work of a collective of engineers in the All-Union Research and Design Institute of Chemical Engineering Industry, headed by A. A. Koryaginym, are devoted to the design of new technological systems for drying and generalization of current information and construction of spray dryers. The scientific trend developed by them for creating a complex procedure for the optimization of drying systems (including spray dryers) by taking into account technological, technical-economical and thermodynamic indices of the process appears to have promise.

Four papers devoted to the problems of spray dryers, containing some results of the investigations of the Sverdlovsk NIKHIMMASH, Moscow Power Institute and the Institute of Technical Thermophysics AN UkSSR, were presented in the conference.

Valuable information for the theory and engineering of high intensity spray dryers is contained in the paper by M. M. Gamrekeli and V. I. Davydov "Issledovanie granits ispareniya fakela raspylyennoy zhidkosti v tsilindricheskom reaktore s teplopodvodom ot vysokotemperaturnykh stenok (Investigation of the boundaries of evaporation of the jet of a atomized liquid in a cylindrical reactor with heat supply from high temperature walls)".

The rich experimental material concerning change of the boundaries of complete evaporation of the atomized jet and temperature fields in the drying chamber of the reactor on supplying heat from its sides is original and of practical use. The significance of this investigation is slightly decreased because only water was used as the liquid for atomization.

The essence of the new methods of investigating the processes of the evaporation of drops, including in chambers of spray dryers, is described in the paper of B. I. Leonchika "Metody Issledovaniya protsessov raspylitel'noy sushki (Methods of investigating processes of atomizing drying)". The application of this method allows to improve experimental investigations of the drying of drops under laboratory and industrial conditions, as well as to generalize the accumulated

experimental material during the use of generalized variables, which follow from the proposed system of equations. On this basis it is expedient to analyze and design the processes of drying in individual zones of industrial units, solve problems of approximate simulation.

Results of the investigation of evaporation of liquids in widely used recirculation spray equipments, including computation equation for volume factor of heat transfer; experimental procedure and new experimental data on the peculiarities of the kinetics of drying single suspended drops of high-humidity liquids are given in the paper by O. A. Kremnev, A. A. Dolinskiy and other authors from the Institute of Technical Thermophysics AN UkSSR.

In spite of the specific nature of the process of spray drying associated with dispersed state of a liquid, general developments in the theory, technique and technology of drying have fundamental importance for its preception and improvement.

Such developments are contained, particularly, in the paper by A.V. Lykov, V. A. Sheyman and P. S. Kuts "Priblizhyennyy metod rascheta temperatury materiala v protsesse sushki (Approximate method of calculating temperature of a material during the drying process)". Calculations of the temperature of particles in the chambers of spray dryers by the new procedure, based on the use of Rebinder's number, are extremely useful during the solution of several problems, especially technological.

The application of the methods of measuring particle temperature, developed in MEI, is effective for experimental determination of the relationship between Rebinder's number and the average moisture content of particles for various technological parameters.

The application of scientific achievements in the adjoining fields of engine building, meteorology, conditioner building etc., has great significance for developing the theory of spray drying. Thus, for example, in the generalized monographs of B. V. Raushenbakh, S. A. Belyy, S. M. Il'yashenko, A. V. Talantov, E. K. Moshkin and other authors the physical basis of the processes of the movement of evaporating drops are described and methods of calculating spatial-time changes of the parameters of spray jet, features of the dynamics of spray chambers are given.

The work of M. A. Fuks in the field of the mechanics of aerosols and corresponding processes of heat and mass transfer are the bases for solving problems connected with the unsteady state and mutual interaction of drops and particles.

Investigation in the field of conditioner construction (E. E. Karpis, O. Ya. Kokorin, I. A. Shepelev and others) allowed to considerably increase the information on heat and mass transfer in spray chambers and to solve complex problems of aerodynamics.

Some general problems of the investigations of spray drying are described in one of the papers presented in this section.

In the conclusion we mention that multiple plan and coordinated activities of the collectives of engineers-researchers are necessary for successfully solving these problems, for designing systems and units of high intensity, for realizing qualitatively new design principles. Indispensable conditions in this activity are the use of achieved modern theory of transfer, techniques and methods of thermo-physical experimentation; the analysis of generalized data on industrial investigation; development of scientific bases of the technology of spray drying.

Only on this basis it is possible to create complex, widely applicable procedure of approximate simulation, technological forecasting, design optimization of existing and newly designed spray dryers.

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